Alternatives Analysis for the RGP/GP
For Gravel Removal from the Chetco River

***Project Purpose and Need*:**

The purpose of the project is to provide the region with available, high quality, construction aggregates used to make concrete, asphalt and base rock for roads, bridges, commercial and residential construction.

For the Freeman and Tidewater operations, the processed sand, gravel and concrete products are supplied to local, state and federal customers for the infrastructure maintenance and improvement of the southern Oregon and northern California coastal communities. Customers include ODOT, CalTrans, Curry County Road Department, Del Norte County Road Department, California Pelican Bay Prison, the Brookings Airport, Crescent City Airport, Gasquet Airport, Harbor Water District, harbor Sanitary District and the commercial retail and residential construction industry.

Generally speaking public works projects consume 60% of the aggregate produced in the country. Under current the current economic climate in Oregon, those percentages are much higher. Both housing and commercial development markets have collapsed. Federal stimulus dollars are focused on public work projects. Public works represent 90% of Tidewaters work and 50% of Freeman Rocks work.

The aggregate proposed for extraction by South Coast Lumber will be used for road drainage projects, road surfacing and as a base for stabilization of the log and lumber storage yards. South Coast Lumber manages approximately 95,000 acres of commercial timberland located mostly in southern Curry County. It is estimated that there are over 500 miles of actively managed logging road on these timberlands that require regular maintenance. The application of high quality clean river gravels greatly reduces erosion and storm runoff into adjacent streams.

Project Criteria
In order to meet the project purpose and need, the projects must meet the following criteria:

- *Aggregate quality:* The aggregate must meet the quality standards for the manufacture of asphalt and concrete;
- *Aggregate quantity:* The quantity of material produced meets the future local demand for aggregate;
- *Aggregate production costs:* The production costs, including mining and processing, are reasonable for the local market;
- *Proximity to Market:* The aggregate facility must be located in close proximity to the local market to minimize transportation costs;

- *Existing infrastructure:* The aggregate facility must utilize existing production and transportation infrastructure.

Aggregate Quality: Public road construction and maintenance projects have stringent requirements for the materials that may be used as the aggregate component in the manufacture of asphalt and concrete. Federal and state highway construction specifications dictate that the aggregate must meet or exceed specific test values, such as for abrasion and impact resistance, particle roughness and maximum percent of fines.

Quantity of aggregate and future demand: Average annual per capita consumption is 10 tons per person per year, with rural counties often exceeding 12 to 15 tons per person (William Jaeger, The Hidden Costs of Relocating Sand and Gravel Mines, Science Direct, Resource Policy 31, 2006). Curry County and Del Norte County have a population of 50,623, resulting in a predictable demand of 500,000 to 750,000 tons per year. Historically, the majority of high quality aggregate for asphalt and concrete was harvested from riverine materials. Attached is a list of projects and their approximate demand for aggregate.

Aggregate Production Costs: Processed Chetco River aggregate currently sells for an average of $14 a ton. Production costs are highly variable from operator to operator. Quality, quantity, cleanliness of material, distance to project site, prevailed wages, equipment used and many other variables represent the costs of producing material. The most important factor is distance to market. Transportation costs are the single greatest expense in delivering material to market.

Proximity to Market: Aggregates are a ubiquitous and indispensable commodity with a relatively low market value in relation to its weight. A key characteristic of aggregate markets is that in most settings the markets are local rather than national, or even regional. This is because aggregate has a low value to weight ratio which can make transportation costs a major share of the total cost of production. Generally, an aggregate mine's market area is within 30 miles of the source. Jaeger, 2006, stated that a basic conflict between satisfying the location-specific, predictable demand for mineral aggregates at low cost and the desire on the part of many communities to have mining operations located far away raises the cost of delivering aggregates to consumers. The effects can be significant given the high demand of these indispensable, but often overlooked, products.

Range of Alternatives for Sources of Aggregate:

The need for good quality aggregate for construction has been clearly established in the prior sections, but the question may still be asked as to whether alternative sources exist that satisfying the aforementioned need. For example: Are there other sources of aggregate that could be used just as effectively? Are there other sites on the river that may be better suited? Are there other extraction methods that could be used on the river that would be better than what is proposed? These alternatives are listed below and will be discussed in more detail in the following section.

The range of alternatives to the proposed action on the Chetco River includes:

1. Alternative sources of aggregate, including;
    - Upland sources of aggregate;
    - Recycled aggregate material;
    - Importing aggregate from outside the area; and
    - Recovering dredged material from the mouth of the Chetco River.
2. Alternative extraction sites on the river. There are several gravel bars within the lower Chetco River that have been mined in past years and could be alternative extraction sites if one or more of the proposed sites are rejected. Possible alternate sites may include:
    - Estuary dredging;
    - The lower bar below Hwy 101 bridge;
    - Curry Bar at about RM 1.5;
    - Social Security Bar at about RM 3; and
    - Harroun Bar at about RM 9.5.
3. Alternative extraction methods. The extraction methods proposed are not the only methods that could be used to recover the gravel. Various methods have been used in the past and may be more appropriate for some sites than what is proposed. The possible alternative mining methods that will be examined include:
    - In river dragline or clam shell;
    - dredging; and
    - estuarine bar scalping.
4. Alternative of no extraction.

Evaluation of Alternatives

Partners to this permit have argued that there may be good alternative sources of aggregate available in the area without having to mine gravel from the rivers. Suggested sources include upland rock quarries, recycled aggregates, importing aggregates, and recovering dredged aggregate from the Chetco River. As discussed below, only one of these alternatives meets all the criteria listed. If a specific criterion is not individually addressed in the discussion below, it was not a concern in the evaluation of that criterion.

Upland Rock Quarries: In Curry County, aggregates come from two sources – river gravel and upland rock quarries. River gravel was easily mined, replenished each year, and was of high quality meeting many construction applications. Metamorphic and igneous rock formations dominate the upper watershed of the Chetco River. These rock formations, through the natural erosion processes, provide a durable, high quality rock that is particularly suitable for use in the manufacture of concrete and asphalt.

As an alternative, these metamorphic and igneous basalt formations, generally, would meet the quality and quantity requirements for construction grade aggregate material. However, these deposits are located where they can not be utilized. The upper Chetco watershed is located in the Kalmiopsis Wilderness area and the Wild and Scenic Section of the Chetco River. Access to these high quality aggregates currently comes from the erosion processes that transport these quality aggregate materials down the Chetco River.

Developing a quarry in the Wild and Scenic Section of the Chetco River and the Kalmiopsis Wilderness is not a viable option because the Kalmiopsis has a mineral withdraw that does not allow new operations. Congressman Peter Defazio has introduced legislation that proposes a mineral withdraw on the Wild and Scenic Section of the Chetco River. Provided a willing seller of a pre-existing quarry could be found, a mine site could be evaluated for its marketability. Distance to market is the most important factor to consider as trucking costs are a major portion of the product cost. In addition, the Forest Service charges a per ton-mile fee to travel over their roads. This would add significant additional costs. Generally, transportation to an aggregate market area does not exceed 30 miles. Jaegar, 2006.

Quantity and quality would be determined by drilling multiple holes over a proposed mine site ($5,000 per hole). Quality is determined by sending samples into an independent lab for testing. Samples are tested for abrasion resistance, chemical resistance and durability of material. Quantity is necessary to determine if the material is marketable at a reasonable price over a significant period of time. Quantity multiplied by market value less development/processing and transportation costs must equate to a reasonable return on investment to make the material marketable. Quantity and quality considerations are probably not an issue for the upper Chetco watershed.

Permitting consideration would include noise, dust, transportation systems, environmental issues, and evaluation of endangered species. Permits would have to be obtained from the Department of Geology and Mineral Industries, Curry County, Department of Environmental Quality and many other state and federal agencies. Permitting around a wilderness area alone makes this option not a practical or even realistic alternative.

Development cost of moving overburden, blasting to access material, processing equipment and transporting equipment are significant costs to relocating the industry into the Kalmiopsis. Processing and storing overburden is generally a significant cost and creates a whole different set of environmental concerns regarding where to store the material. Crushing, transporting, and infrastructure equipment would have to be purchased. This type of processing equipment is different than processing equipment for riverine materials. For example, paddle wheel scrapers would be of no value in mining quarry material. Bulldozers, rippers, rock drills, front end loaders would have to be purchased. Blasting metamorphic and igneous basalt is generally required to make the material available for processing. Blasting is expensive and a dangerous activity done by qualified and licensed companies. It has impacts on endangered avian species that might be located nearby. Conveyors systems would be new equipment that would transport the

blasted material to "jaw" and "cone" crushers. Crushed material would then be conveyored and sorted into different products depending on the specification required for different jobs. The material would then be loaded and transported by trucks to the market area. Roads would have to handle significant increased heavy traffic. Forest service roads would likely have to be redesigned to handle the weight and frequency of the transported loads. Infrastructure development for new sites is costly and often costs in the ten of millions to get a site up and running. Infrastructure costs would likely make developing sites in or around the Kalmiopsis Wilderness not a practical alternative.

In contrast to the upper watersheds higher quality material, upland quarries in southwestern Curry County, with a few exceptions, do not produce the high quality rock equal to the river gravel obtained from the Chetco River. The geology of the western slope of Curry County consists of sandstone, shale, mudstone, and minor amounts of marine basalt. (J. Rose Wallick, Scott W. Anderson, Charles Cannon, and Jim E. O'Connor, Channel Change and Bed-Material Transport in the Lower Chetco River, Oregon, USGS Open- File Report 2009-1163) Quarries in the sandstone rock type are typically suitable for use as fill or other uses not demanding high quality, durable rock.

Western basalt formations are generally of better quality than the sandstone, shale and mudstone formations, but they still do not consistently meet the quality demands required for construction, and rarely, meet the demands required for asphalt and concrete aggregate. (Dorian Kuper, Tom Kuper, Certified Engineering Geologists, Kuper Consulting LLC Future Oregon Coastal Aggregate Resource Potential, 2001, Special Report to Oregon Concrete and Aggregate Producers Association.)

These western basalt formations do occur in the local market area and needs to be further discussed. If these upland quarries met quality standards for asphalt and concrete and contained enough aggregate material to meet local demand, then these quarries would be the most probable alternative to riverine sources. However, as explained in the literature, most of the upland rock formations along the Oregon coast, including western Curry County, are composed of sandstone, mudstone and other marine basalt that either contains too much fine material when crushed, or do not meet abrasion resistance or chemical weathering standards for use in asphalt or concrete. Aggregate material from upland quarries in Curry County is generally used as fill material, road gravel, rip rap and other aggregate uses not requiring stringent specification standards. Using these lower quality materials for these non stringent specification purposes reduces demand for riverine sources. They are not a substitute for riverine sources.

Both Tidewater and Freeman Rock operate upland quarries, these sources have been tested repeatedly and do not meet the standards for asphalt and concrete. Further processing of these quarry aggregates will not change the underlying quality of the material. Quality of the rock is dependent upon the underlying chemical characteristics which include such things as rock type, origin, age, depositional history, clay composition and distribution, fragment composition, and cementation to name just a few problems. Even if the small pockets within the quarry have the desirable hardness, abrasion resistance, weathering resistance, and durability characteristics, the sand

equivalent (SE) does not meet the quality specification due to clays that is intermixed with the material. Where found, these small pockets of material are utilized, but are not reliable, consistent and are not a practical alternative.

Recycled Aggregates: Recycling of aggregate products such as asphalt and concrete is a viable source of aggregate, but the quality and quantity is insufficient to meet all the local construction needs. Recycled aggregate is also not suitable for all aggregate applications. It is currently used for base rock and as a portion of the aggregate feed to manufacture new asphalt. Reclaimed Asphalt Pavement (RAP) is manufactured by grinding old asphalt pavement during the reconstruction of a roadway. RAP is commonly used by Tidewater and may comprise up to 25 percent of the aggregate input to manufacture asphalt pavement on major road construction projects. Reclaimed concrete aggregate (RCA) is manufactured by crushing and sorting old concrete. This alternative already supplements aggregate demand in the local area, but at a very minor level. Tidewater and Freeman Rock recycle asphalt and concrete when the market makes it available. Recycled material is insufficient in quantity to meet local demand and it is also unreliable as a consistent source of construction grade aggregate material. Its real value is in recovering asphaltic oil, reducing the industry's carbon footprint and reducing inputs to landfills.

Importing Aggregates: Jaeger, 2006, reported that "Exceptions to this reliance on local sources arises in locations with direct access to very low cost shipping by barge, ship or rail, or where no supplies exist in close proximity." Brookings has no rail facilities. Barging and trucking are the primary alternative sources of importing aggregates.

The importance of transport costs for aggregate markets is not in dispute (Jaeger, 2006). Haul rates vary by transportation mode. For example: British Columbia has been exporting aggregates from Victoria, British Columbia, by barge to Seattle, San Francisco Bay, Los Angeles and Long Beach for decades. According to a recent report from agencies in British Columbia, which assessed the market in Oregon, $10 a ton would be the lowest barge rate available to Portland for a 10,000-ton load (2003 dollars and rate). Adjusted for inflation and the added distance to Coos Bay, the shipping cost today would be about $14. In addition, there would be handling costs to get the material off-loaded and into trucks. Thus, the delivered price of imported gravel from Canada in 2008 would be close to $21 a ton in Coos Bay. Transporting the material an additional 107 miles to Brookings would increase the cost of the imported aggregate to over $35.00 a ton.

Truck hauling is the most used mode of transportation for aggregate delivery. Truck rates per ton-mile are on average $0.35. Incremental costs associated with adding additional miles ranges from $0.16 to $0.22. For example: Aggregate could be purchased as far away as Medford. Transportation costs for a 35 ton truck and trailer over 125 miles would cost $43.75 per ton delivered or $1,531.25 per load. Processed Chetco River aggregate currently sells for an average of $14 a ton. Importing aggregates from available sources is extremely cost prohibitive. Because of the high costs of transportation, importing sand and gravel is not a practicable alternative.

Recovering Dredged Aggregate: Every year the federal government dredges aggregate out of the mouths of the Chetco and Rogue River estuary for navigational purposes. The Operations Branch of the Army Corps of Engineers (COE) annually dredges an average of 30,000 cubic yards of sand and gravel out of the Chetco River. A good percentage of this material is purported to be useable sand and gravel; though how much is not known for sure. The COE's dredging activity involves the Yaquina, a bottom dump suction dredge that is designed to dump the dredged material off shore and not on shore. Access to dredged aggregates would require the COE to invest in the necessary infrastructure to off load the material to shore. This material could be a viable alternative. It is close to market, probably high quality, could be processed at current sites. However, to make the needed changes to the Yaquina and develop off loading facilities in the estuary to recovery this aggregate material would be cost prohibitive based on the relatively small amount of material annually removed from the river. Developing off loading facilities in the estuary would also further degrade the estuarine habitat. These two factors make recovering dredged material not a practicable alternative.

Alternate River Gravel Sites: River gravel is a renewable resource because the source for the gravel is virtually unlimited as long as chemical and mechanical erosion continues to act on the source rock and the river continues to flow to bring the rock down river. Even though the source is virtually unlimited, the rate at which the rock moves down river is finite and variable, depending on geologic and climatic factors. Extraction of river rock, therefore, must be in harmony with the rate of replenishment to maintain its renewable status. In addition, river gravel extraction plans must be designed so that it does not disrupt the geomorphology and dynamics of the river system, including the biological balance. In addition, the mechanical process that the gravel undergoes as it moves down the river naturally removes the more friable rock types by disintegration and cleans the remaining rock to remove the fine clay particles that affect its quality for construction purposes. The resulting gravel has a higher quality than can be procured from local upland sources. Alternate gravel bar sites along the Chetco meet many of the criteria laid out. These sites would be close to market, have sufficient quality and quantity of sand and gravel and would be somewhat predictable and readily available. The difficulty is that access to these alternate gravel bar sites would involve constructing new roads through other property owners living along the Chetco River. Though the gravel bars themselves are owned by the Department of State Lands, permission would have to be obtained from these adjacent landowners controlling access to these sites. Additionally, mining alternate bars would require access through adjacent riparian areas. Adverse environmental impacts to habitat could occur. Federal and state regulators would have to permit these intrusions. In comparison, current gravel extraction sites have well developed access points, infrastructure investments and riparian areas are already impaired from years of use.

As an example, sand and gravel has been removed from the Freeman Bar area for over 40 years and has proven to be a high quality and high quantity renewable resource. Past removals of sand and gravel have been by a paddle scraper and/or by dump trucks that were filled by a front-end loader/excavator. The sand and gravel is moved through

established access points from Freeman Bar to an upland stockpile (bar run pile) located on land owned and managed by Freeman Rock. The infrastructure investments of Freeman's upland site includes rock crushing equipment, aggregate washing and screening equipment, ready-mix concrete plant, supporting shops and business offices. These infrastructure investments are fixed and cost in the millions of dollars. These necessary infrastructure investments to run an aggregate business form the base of the Freeman Rock organization.

1. Estuary Dredging: It has been suggested that river gravels could be obtained from the estuary by dredging in the section from the upper limit of the COE Yaquina dredging to the Hwy 101 Bridge and above. This would increase the navigational capabilities of the lower estuary and at the same time obtain river gravel for aggregate uses. Currently, the river bars within the estuary are markedly increasing in size which restricts the channel and area for navigation. Dredging within this length of the estuary would tend to deepen the estuary and disrupt the rearing habitat for the salmon. At the current time, operators do not have the necessary dredging equipment which would involve barges and an in- water dredging ship like the Yaquina. There is also little likelihood that the State or the Federal government would permit such an operation because of degradation to the estuary. NOAA Fisheries has systematically eliminated all in water dredging operations in Oregon including on the Umpqua and Willamette Rivers.

2. Lower Bar Below Hwy 101 Bridge: As stated previously, the estuary bars are increasing in size due to the amount of gravel being carried down river to the estuary. This bar is along the north bank and below the Hwy 101. It has how grown to a size that creates a hazard to navigation. In fact, the local sailing club has to discontinue their river sails because the bar size had created a shallow water hazard. Removal or reducing the size of this bar would provide a large quantity of high quality sand and gravel as well as improving the navigation and recreational aspects of the lower estuary. Mining would likely need to be a dredge using a clamshell or dragline or it could possibly be dredged during high water with a suction dredge.

3. Curry Bar: Curry Bar is located within the estuary along the north bank of the river at river mile 1.5. The bar has been mined in the past. The adjacent property is owned by a private party from which permission would have to be obtained for access. The bar is normally under water at high tide so it could be mined only at low tide or by construction of a barrier berm as proposed for Tidewater Bar.

4. Social Security Bar: Social Security Bar is a very large bar located at river mile 3. It is along the north bank of the river and has good access. The elevation of the bar has grown in the past several years. It is a very popular fishing and public recreational site which would pose a safety and logistics problem if it was mined. This bar is also proposed as a possible habitat restoration project. This bar has good possibilities as a site for gravel extraction if the issues could be worked out to assure the safety to the public that also use the bar extensively during the summer.

5. **Harroun Bar:** Harroun Bar is located at river mile 9.5 and is along the north bank. It is the large bar that is located below the 2nd Bridge. This bar has good access through private property and is used extensively during the fishing season. This is a favorite access for drift boats. Because it is accessed through private property, permission would need to be obtained before this site could be mined. Also, because of the popularity of the site in the summer and during fishing season, adequate precautions would have to be taken to assure the safety to the public. This bar has good possibilities as a site for gravel.

6. **North Fork Bar:** This bar is located just upriver of the Freeman Bar. It has been mined in the past and has readily available access for mining. The bar typically builds from sediment transport moving down the North Fork. Enough material sediment moves down the North Fork that during summer flows connection to the Chetco is terminated creating a fish passage barrier. This occurrence has been remedied by mining the bar and opening the connection. Mining this site has benefits that are both economic and habitat related.

***Alternate Extraction Methods*:**

The extraction methods proposed for the four sites on the Chetco River are based on methods applied to other rivers successfully, and methods that have been used successfully in the past at these sites. For the estuary portion of the river that is subject to tidal fluctuations, excavation behind a barrier berm has also been proven to work.

Dragline or Clam Shell: Dragline and clam shell excavation methods were popular in years past when gravel was removed from the bars and within the active flowing river. These methods were used in the estuary as well as in the riverine portion of the river. These methods, if used in the river, will produce a turbidity that may conflict with the Clean Water Act and be harmful to fish and their habitat. Dragline or clam shell dredging is a useful alternative in certain applications where there are other objectives like navigation. However, this extraction method can have more direct impacts to the aquatic habitat including increased turbidity and loss of benthic invertebrates.

Dredging: A suction dredge could be used in the lower estuary portion of the river to remove gravel from the channel and the growing river bars. Dredging with a suction dredge requires considerable logistical support for the operation including special dredge equipment, pipe to transport the dredged material, and a location close by to dewater the material before it can be used. As an example: Tidewater's Ganty property, located just up river from the Hwy 101 Bridge, could conceivably be used as a location for dewatering of the material. It is not known whether any other properties close to the river would be either available or suitable. Logistical and permitting problems are numerous for such an operation, especially the transporting of the material to the site for dewatering, as well as the dewatering process itself. This would be a high cost option with unknown environmental impacts associated with salmon and other food sources for the salmon. This alternative could also result in a direct take of young salmonids rearing in the estuary during operation of the suction dredge. This alternative would provide

some high quality aggregate material but would be extremely costly and have significant environmental obstacles to overcome.

Estuary Bar Scalping: As an alternative to the proposed mining method for the Tidewater Bar site in the estuary, a variation on bar scalping might be employed. During low tide, when the bar is fully exposed, the high parts of the bar could be mined with a front-end loader. As the tide comes back up, the mining operation would cease until the next low tide event. Tide events along the Oregon coast are diurnal so there are two low tide events within a 24-hour period. Depending on the timing, mining could occur during one or both of the tidal events. Some turbidity would be released to the river as the newly excavated area was inundated, but it would last only for a short period of time and would soon dissipate. Less material would be recoverable using this method because no trench would be dug, but the recovery would be quicker and the disruption to the environment would be less.

Evaluation of Not Permitting any Project:

In Curry County, Freeman Rock and Tidewater Contractors are the only two companies that provide river sand and gravel for commercial sale. In a study conducted by ECONorthwest, *An Economic Impact Forecast of the Potential Closure of River Rock Mining on the South Coast of Oregon,* prepared for the South Coast Development Council, June 1, 2007, the closure of river-based mining on the south coast of Oregon would cause the following impacts:

- Economic output would decline by $9.2 million a year taking with it 97 local jobs with wages and benefits totaling nearly $3.4 million.
- The cessation of mining on the rivers would force consumers to secure alternative supplies. The coastal region simply lacks sufficient high quality aggregate sources outside of river rock. The least cost alternative source appears to be gravel from British Columbia, Canada. For large markets, importation can be done efficiently, but this analysis finds that the aggregate market for the three counties is too small for low unit cost shipping. Therefore, replacement aggregate would have to be shipped into Coos Bay at a price of $21 a ton, which is 91 percent higher than the current price from river-based mines in the region.

The long-term implications are serious. Prices for concrete on the south coast are already 44 to 51 percent higher than other major west coast port cities. An increase in gravel from $14 a ton to $35 a ton would increase costs by 250%. Concrete is a critical material for industrial, port, housing, and infrastructure development and the unusually inflated cost of aggregate resulting from a closure of river mining would significantly hinder much needed economic development for the region, which has suffered from persistently low wages and high unemployment. Furthermore, the paucity of quality base rock would further hurt the region's ability to attract major investments, thus further exacerbating the deleterious economic effects of the river mining closures.

would provide some high quality aggregate material but would extremely costly and have significant environmental obstacles to overcome.

Estuary Bar Scalping: As an alternative to the proposed mining method for the Tidewater Bar site in the estuary, a variation on bar scalping might be employed. During low tide, when the bar is fully exposed, the high parts of the bar could be mined with a front-end loader. As the tide comes back up, the mining operation would cease until the next low tide event. Tide events along the Oregon coast are diurnal so there are two low tide events within a 24-hour period. Depending on the timing, mining could occur during one or both of the tidal events. Some turbidity would be released to the river as the newly excavated area was inundated, but it would last only for a short period of time and would soon dissipate. Less material would be recoverable using this method because no trench would be dug, but the recovery would be quicker and the disruption to the environment would be less.

Evaluation of Not Permitting any Project:

In Curry County, Freeman Rock and Tidewater Contractors are the only two companies that provide river sand and gravel for commercial sale. In a study conducted by ECONorthwest, *An Economic Impact Forecast of the Potential Closure of River Rock Mining on the South Coast of Oregon,* prepared for the South Coast Development Council, June 1, 2007, the closure of river-based mining on the south coast of Oregon would cause the following impacts:

- Economic output would decline by $9.2 million a year taking with it 97 local jobs with wages and benefits totaling nearly $3.4 million.
- The cessation of mining on the rivers would force consumers to secure alternative supplies. The coastal region simply lacks sufficient high quality aggregate sources outside of river rock. The least cost alternative source appears to be gravel from British Columbia, Canada. For large markets, importation can be done efficiently, but this analysis finds that the aggregate market for the three counties is too small for low unit cost shipping. Therefore, replacement aggregate would have to be shipped into Coos Bay at a price of $21 a ton, which is 91 percent higher than the current price from river-based mines in the region.

The long-term implications are serious. Prices for concrete on the south coast are already 44 to 51 percent higher than other major west coast port cities. An increase in gravel from $14 a ton to $35 a ton would increase costs by 250%. Concrete is a critical material for industrial, port, housing, and infrastructure development and the unusually inflated cost of aggregate resulting from a closure of river mining would significantly hinder much needed economic development for the region, which has suffered from persistently low wages and high unemployment. Furthermore, the paucity of quality base rock would further hurt the region's ability to attract major

investments, thus further exacerbating the deleterious economic effects of the river mining closures.